

APPENDIX J

**General Health Effects of PBT Chemicals
In Virginia Reports**

APPENDIX J

GENERAL HEALTH EFFECTS OF PBT CHEMICALS IN VIRGINIA REPORTS

U.S. EPA has designated a list of chemicals as Persistent Bioaccumulative Toxic (PBT). These chemicals remain in the environmental for long periods of time, are not readily destroyed, and build up or accumulate in body tissue. Because of heightened awareness of PBTs, this agency is providing general information about the PBTs to further enhance understanding of these chemicals.

The information on the following pages is a summary of general health and environmental hazards and effects for the eight TRI PBTs that were reported by Virginia facilities for 2002. This summary is an abbreviated compilation of chemical information from several public sector (government) and non-public sector publications and Internet sites. The chemicals are:

- Benzo(g,h,i)perylene
- Dioxin and Dioxin-like compounds
- Lead
- Lead Compounds
- Mercury
- Mercury Compounds
- Polychlorinated Biphenyls (PCBs)
- Polycyclic Aromatic Compounds (PACs)

Please note that the information presented is very general and does not suggest the level of public exposure to the chemicals or the risk associated with them. The effects of exposure to any hazardous substance depend on the dose (concentration and quantity), duration (how long one is exposed), the route or pathway by which one is exposed (how one is exposed such as breathing, eating, drinking, or skin contact), personal traits (susceptibility) and habits, and whether other chemicals are present.

There are numerous reference sites for information on the chemicals listed above, and they vary in scientific/technical detail. In this document, several preliminary reference sites are listed for readers with interest in researching more detailed information. Before reaching any conclusion on exposure, risk, and health effects, readers should consult these and other reference sites as well as their physicians for information.

Benzo(g,h,i)perylene

What Is It?: It appears as pale yellow green crystals and is categorized as a polycyclic aromatic hydrocarbon (PAH). It is usually formed as a by-product of incomplete combustion.

Sources and Uses: Fossil fuel (No. 2 & 6 Fuel Oils and gasoline) combustion for heat and power generation (including motor vehicle operation) is the primary source of Benzo(g,h,i)perylene. However, other industrial processes may also contribute to its formation. These processes may be synthetic fuel production, coal processing, asphalt paving, and petroleum refining.

Environmental Fate and Exposure: This substance is normally released to the environment via stack air or scrubber wastewater. It can be absorbed into the body by inhalation of its aerosol, through the skin, or via food chains important to humans. Bioaccumulation tends to take place in oils and fats. It has been found to be highly toxic at relatively low concentration to fish, daphnia, and algae.

Health Effects: Not classifiable as human carcinogen.

Regulatory Limits: It is listed as a priority pollutant under the Clean Water Act (CWA) and is also regulated under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) with a release reportable quantity of 5,000 pounds or more.

References: EPA PBT Chemicals Final Rule (40 CFR Part 372 - (VI) Summary of Public Comments & EPA Responses (G2)); Guidance for Reporting Toxic Chemicals: Polycyclic Aromatic Compounds Category, EPA 745-B-01-00X, March 2001; Guidance for Reporting Toxic Chemicals: Pesticides and Other Persistent Bioaccumulative Toxic (PBT) Chemicals, EPA 260-B-01-005, August 2001; International Chemical Safety Cards - (<http://www.itcilo.it/english/actrav/telearn/osh/ic/191242.htm>); EPA Integrated Risk Information System (IRIS) - (<http://www.epa.gov/iris/>); U.S. Dept. of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR) - (<http://www.atsdr.cdc.gov/toxprofiles/>).

Dioxin and Dioxin-Like Compounds

What Are They? Dioxin is a commonly used term for a family of toxic chemicals that share a similar chemical structure and common mechanism of toxic action. The 17 dioxin and dioxin-like compounds listed by EPA under the TRI PBT rule are all multiple chlorinated compounds.

Sources: Dioxin and dioxin-like compounds are formed as a result of incomplete combustion of fuel (mainly oil, coal and wood), incineration of municipal solid waste, incineration of medical waste, residential burning of wood and household waste, and forest fires. Dioxin and dioxin-like compounds can be generated as unintentional by-products from secondary copper smelting, cement kiln operations, metal production, wood preservative process, or chlorine bleaching of wood pulp.

Uses: Dioxin was found to be a contaminant of the herbicide 2,4,5-T (trichlorophenoxyacetic acid). It was also a contaminant of in the defoliant Agent Orange. The dioxin and dioxin-like compounds category reported under TRI does not include any PCBs or PBBs.

Environmental Fate: Trace amounts of dioxin and dioxin-like compounds are mainly introduced to the environment through air releases. Because of their persistence in the environment and atmospheric deposition, they can be carried to far away distances before being deposited onto plants, buildings and pavement, soil and water. They can be distributed into water bodies through urban area storm water runoff or soil erosion.

Exposure: Dioxin and dioxin-like compounds are widely distributed in our environment, in very low parts per trillion amounts. These chemicals can accumulate in fatty tissues of animals, and these accumulations can pass up the human food chain. According to dioxin research, most people have a detectable level of dioxin in tissues and our exposure came mainly from eating animal fat from beef, pork, poultry, fish, and dairy products. Most of the meat and dairy products we consume do not come from local but from national food supply infrastructure; therefore, most of our dioxin exposure does not come from local sources within our community.

Health Effects: Dioxins are classified as probable human carcinogens. The best studied member of the dioxin family - 2,3,7,8 TCDD - is a known human carcinogen. Adverse non-cancer health effects have been observed both in animals and to a limited extent, in humans. Health effects specifically observed in humans are changes in early childhood development (immune system and learning behavior) and hormone levels (endocrine disruption), and serious skin disease called chloracne. In animals, these effects include changes in hormone systems, fetal development, reduced reproductive capacity, and immunosuppression.

Regulatory Limits: EPA and other researchers are working to resolve questions such as

- Is there a low level of exposure that is harmless?
- Are current background exposure levels harmful to adults or children?
- What are the most important sources of dioxins?

References: USEPA web site on Persistent Bioaccumulative and Toxic (PBT) Chemical Initiative (<http://www.epa.gov/pbt/dioxins.htm>). EPA PBT Chemicals Final Rule (40 CFR Part 372 - (VI) Summary of Public Comments & EPA Responses (G1)). Emergency Planning and Community Right-to-Know Act - Section 313: Guidance for Reporting Toxic Chemicals within the Dioxin and Dioxin-Like Compounds Category, EPA-745-B-00-021, Dec 2000. EPA National Center for Environmental Assessment, draft publications and web sites: Draft Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds, Sept. 2000; (<http://cfpub.epa.gov/ncea/cfm/dioxin.cfm?ActType=default>) and (<http://cfpub.epa.gov/ncea/cfm/nceahome.cfm>). Hawley's Condensed Chemical Dictionary, Van Nostrand Reinhold Company, Inc. (11th Edition, 1987)

Lead and Lead Compounds

What Are They? Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment. Lead can combine with other chemicals to form what are usually known as lead compounds or lead salts.

Sources: Much of lead comes from human activities including burning fossil fuels and solid waste, mining, and manufacturing (e.g., copper and lead smelters, glass manufacturing plants, and metallic mineral processing plants). Human activities (such as the former use of "leaded" gasoline) have spread lead and substances that contain lead to all parts of the environment.

Uses: Lead has many different uses. It is used in the production of batteries, ammunition, monitors, metal products (solder and pipes), cable covering, and devices to shield X-rays. Lead is also used in scientific equipment (circuit boards for computers and other electronic circuitry). Because of health concerns, lead from gasoline, paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years.

Environmental Fate: Lead itself does not break down, but lead compounds are changed by sunlight, air, and water. Once lead falls onto soil from the air, it usually sticks to soil particles. Movement of lead from soil into groundwater will depend on the type of lead compound and the characteristics of the soil.

Exposure: Exposure may come from eating food or drinking water that contains lead; spending time in areas where lead-based paints have been used and are deteriorating; working in a job where lead is used; using health-care products or folk remedies that contain lead; and engaging in certain hobbies in which lead is used (e.g. stained glass).

Health Effects: Lead is an irritant to the eyes, nose, and throat. Lead can affect almost every organ and system in your body (e.g. cardiovascular, gastrointestinal, hematological, hepatic, renal, endocrine, immunological, reproductive etc.). The most sensitive is the central nervous system. Young and unborn children are more vulnerable to lead poisoning than adults. The effects are the same whether it is breathed or swallowed. At high levels, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead may cause anemia. It can also damage the male reproductive system. The Department of Health and Human Services has determined that lead acetate and lead phosphate may reasonably be anticipated to be carcinogens based on studies in animals. There is inadequate evidence to clearly determine lead's carcinogenicity in humans.

Regulatory Limits: USEPA: (a) Action Level of 0.015 mg/L for water treatment facilities; (b) Human Health Water Quality Criteria for aquatic organisms and drinking water of 43 ug/L; (c) Reference air concentration (RAC) of 9.0E-02 $\mu\text{g}/\text{m}^3$.

HUD: Action Level for lead-based paint of 1 mg/m^2 . OSHA: (a) Permissible Exposure Limit (PEL) of 0.05 mg/m^3 averaged over an 8-hour workshift and (b) Blood level of concern of 40 $\mu\text{g}/\text{dL}$ NIOSH: Airborne Exposure Limit of 0.1 mg/m^3 averaged over a 10-hour workshift.

References: (1) Agency for Toxic Substance and Disease Registry (ATSDR), 1999, Toxicological profile for lead, Atlanta, GA, U.S. Department of Health and Human Services.
(2) USEPA, 2001, National Primary Drinking Water Standards, Office of Water.
(3) New Jersey Department of Health and Senior Services, 2001, Hazardous Substance Fact Sheet
(4) Risk Assessment Information System (RAIS), 2003, http://risk.lsd.ornl.gov/rap_hp.shtml

Mercury and Mercury Compounds

What Are They? Mercury is a naturally occurring metal in trace amounts in igneous and sedimentary rocks. The elemental metallic mercury is a shiny, silver-white, odorless liquid.

Sources: Mercury is found principally in the form of the ore cinnabar (mercury sulfide) and elemental mercury is extracted through simple oxidation process. Trace amounts of mercury or mercury compounds are found in fuel oil, coal, copper ores, sulfide ores, and gold ores as impurity. In the combustion of the fuel, mercury or mercury compounds are converted to other forms of mercury compounds or to elemental mercury. Under certain recovery processes, mercury can be recovered from scraps from secondary smelting operations; as a by-product of gold mining, scrapped equipment, instrument, and electrical devices; and industrial waste.

Uses: Mercury and mercury compounds are used in thermometers, thermostats, some batteries, cameras, cathode tubes, some calculators, small appliances, mercury vapor lamps, fluorescent lamps, electrical switches, hearing aids, common household disinfectant/cleaners, electrodes, dental fillings, and antifungal skin ointments. In industrial applications, mercury is used in custom compound resins and chlor-alkali (production of chlorine gas and caustic soda) manufacturing. However, the chlor-alkali process using mercury cell has declined significantly over the last 20 years. Mercury is also used as fluid bearing and fluid clutches that require a heavy liquid. It is fairly non-reactive and is very resistant to corrosion.

Environmental Fate: Inorganic mercury or mercury compounds can enter into the air through stack exhaust from manufacturing plants, or combustion of fuel or waste. It can enter the water or soil from natural deposits, rain deposition, water runoff from industrial sites or fungicides containing mercury, or wastewater treatment sludge. Organic mercury, such as methyl mercury, may be formed in water and soil by bacteria. It can build up in fish tissues and in other organisms and the level of mercury or mercury compounds accumulates up the food chain.

Exposure: Exposure may come from eating fish or shellfish contaminated with or seed grains containing a high level of methyl mercury; breathing vapor in air coming from incinerators or industrial facilities that burn mercury-containing waste or fuels; or release of mercury during dental and medical treatments.

Health Effects: Methyl mercury is considered the most harmful form because it can pass through the blood stream into the brain more readily than any other form. Exposure to methyl mercury is more dangerous for young children than for adults and can interfere with their normal development. High levels of exposure to any form of mercury can result in permanent damage to the brain, kidney, and developing fetus. Short-term exposure can cause lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

Mercury or mercury compounds have not been determined to be carcinogenic to humans due to lack of data.

Regulatory Limits: The U.S. EPA has set a limit of two parts of mercury per billion parts of drinking water (2 ppb) and has required reporting of discharges or spills of mercury containing material equal to or greater than one pound (1 lb.). U.S. FDA has set a maximum permissible level of one part of methyl mercury in a million parts of seafood (1 ppm). OSHA has set a limit of one milligram of mercury per 10 cubic meters of work place air (1 mg/10m³) that should not be exceeded during any of the workday.

References: Mercury fact sheet - University of Wisconsin - (<http://www.geology.wisc.edu/~jill/hg.html>); Emergency Planning Community Right-to-Know Act - Section 313: Guidance for Reporting Toxic Chemicals: Mercury and Mercury Compounds Category, EPA 260-B-01-004, August 2001; U.S. EPA PBT web site - (<http://www.epa.gov/pbt/mercury.htm>); International Chemical Safety Cards (www.itcilo.it/english/actrav/telearn/osh); New Jersey Department of Health and Senior Services, Hazardous Substance Fact Sheet - Mercury and on other Mercury compounds.

Polychlorinated Biphenyls (PCBs)

What Are They? PCBs are man-made substances (chlorinated compounds known as congeners). They are oily liquids or solids and are colorless to light yellow, and have no smell or taste. Many commercial PCB mixtures are known by the trade name Aroclor.

Sources and Uses: PCBs were manufactured as coolants and lubricants because they do not burn easily and are good insulators. Manufacturing of PCBs stopped in the United States in 1977 due to their ability to build up in our environment and cause harmful health effects. Although their production was ceased, trace amounts of less than or equal to 50 parts per million (ppm) of PCBs can still be found in dielectric fluid (utility transformer fluid.)

Environmental Fate: PCBs entered the environment during their manufacturing, use and disposal; from accidental spills or leaks during their transport; and from leaks or fires in products containing PCBs. They can also be released to the environment from hazardous waste sites, illegal or improper disposal of industrial wastes or consumer products, or burning of some industrial wastes in incinerators. Once entered into the environment, they persist there for a very long time. In air, PCBs can travel long distances and can be deposited far away from its source of origin. They bind strongly to soil. A small amount of PCBs may dissolve in water, but largely, they stick to organic particles or sediments.

Exposure: Small organisms and fish take up PCBs. They can accumulate up the food chain by other animals that eat these aquatic animals, reaching levels that may be many thousands of times higher than in water. Humans (especially children) can be exposed to PCBs through skin contact or unintentional ingestion of PCB contaminated soil from hazardous waste or illegal dump sites, or old PCB-containing electric appliances, equipment, or transformers. Exposure can also come from eating PCB-contaminated fish or fish eating animals, or breathing vapor where electrical equipment containing PCBs were released or unprotected.

Health Effects: PCBs are probable human carcinogens and known carcinogens to animals. They posed multiple negative chronic health effects such as liver damage; nervous system damage; acne-like skin rash; reproductive damage in adults; and neurobehavioral and immunological changes in children. PCBs can be passed to an infant through mother's milk. Acute (short-term) exposure can result in irritation to the respiratory system and difficulty in breathing.

Regulatory Limits: Safe Drinking Water Act (SDWA) regulations set PCBs limit of 0.0005 milligrams per liter of drinking water (0.0005mg/L). Discharges, spills or accidental releases of one (1) pound or more of PCBs into the environment must be reported to EPA. The Federal Food and Drug Administration (FDA) requires that infant foods, eggs, milk and other dairy products, fish and shellfish, poultry and red meat contain no more than 0.2 – 3 parts of PCBs per million parts of food (0.2 – 3 ppm). The Toxic Substance Control Act (TSCA) regulation has set a “non-PCB-containing” transformer fluid limit to less than or equal to 50 parts of PCBs per million parts of fluid (50 ppm).

References: U.S. Dept. of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR) - (<http://www.atsdr.cdc.gov/toxprofiles>). USEPA web site on Persistent Bioaccumulative and Toxic (PBT) Chemical Initiative (<http://www.epa.gov/pbt/pcbs.htm>). Public Health Implications of Exposure to Polychlorinated Biphenyls (PCBs), U.S. Public Health Service, The Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services and The U.S. Environmental Protection Agency, Feb. 2, 1999.

Polycyclic Aromatic Compounds (PACs)

What Are they? Polycyclic aromatic compounds (PACs) are also known as polycyclic aromatic hydrocarbons (PAHs). Although there are over 100 of these chemicals, only 21 of them are listed by TRI to persist in the environment and/or bioaccumulate in living tissues. Most are formed during the incomplete combustion (burning) of fuel, garbage, agricultural by-products, forest fires, volcanoes, or other organic substances like tobacco, or charbroiled meat.

Sources and Uses: Some PACs are manufactured and they exist as colorless, white, or pale yellow green solids. They are components of fossil fuels and can be found in coal tar, creosote, and roofing tar. Few are used in medicines or to make dyes, plastics, and pesticides. Other sources of PACs can be found in industrial processes such as iron foundries, petroleum processing, primary aluminum producers, coke ovens, pulp mills, portland cement kilns, and carbon black manufacturing. PACs are emitted from vehicle exhausts and as soot. A large portion of the PACs reported by Virginia facilities were the result of fuel usage and incomplete fuel (oil, gas, or wood) combustion.

Environmental Fate: PACs can enter into the air from combustion exhaust and by attaching to dust particles. Some can breakdown by reacting with sunlight or other chemicals in the air over a period of time. PACs entered into the water through discharges from industrial and wastewater treatment plants. Most do not dissolve readily in water; therefore, they tend to stick to solid particles and settle to the bottoms of lakes or rivers. Because they have aromatic hydrocarbon properties, they can readily evaporate into the air from soil or surface waters. PACs move through soil by attaching tightly to particles and may contaminate ground water or be absorbed by plants.

Exposure: Exposure to PACs can occur through breathing air containing PACs; coming in contact with contaminated water or soil near hazardous waste sites; consuming contaminated water, cow's milk, or other vegetable, cereal, or beef products; and eating grilled or charred meats.

Health Effects: Laboratory animal studies have shown that PACs can cause harmful effects on the skin, body fluids, animal reproductive capability, and their ability to fight diseases after both short and long term exposures. Several PACs are known animal carcinogens (cancer causing); some are determined by the International Agency for Research on Cancer (IARC) to be possible or probable human carcinogens; and some have not been classified for carcinogenic effects by U.S. Dept. of Health and Human Services.

References: EPA PBT Chemicals Final Rule (40 CFR Part 372 - (VI) Summary of Public Comments & EPA Responses (G3 -4)); Guidance for Reporting Toxic Chemicals: Polycyclic Aromatic Compounds Category, EPA 745-B-01-00X, March 2001; International Chemical Safety Cards (www.itcilo.it/english/actrav/telearn/osh/); EPA Integrated Risk Information System (IRIS) - (<http://www.epa.gov/iris>) on selective PACs; U.S. Dept. of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR) - (www.atsdr.cdc.gov/toxprofiles) on selective PACs.